PAL

determining a fair and credible carbon price

Fact sheet — Carbon Intensity Weighting

A unique carbon pricing system that is future-proofed and science-based, transforming the way carbon prices are set for now and for the future.

The PAL Carbon Intensity Weighting – CIW

A particular problem in carbon pricing is that a one-size-fits-all carbon price is a blunt instrument for encouraging behavioural change. A spectrum of prices based on impact (PAL's Carbon Intensity Weighting) is more effective as well as future-proof.

A future-proof alternative to subsidies

Perhaps the most valuable feature of CIW is that it incentivises carbon emitters to reinvest in renewables & lower carbon intensive fuel technologies. It is a powerful alternative to subsidies.
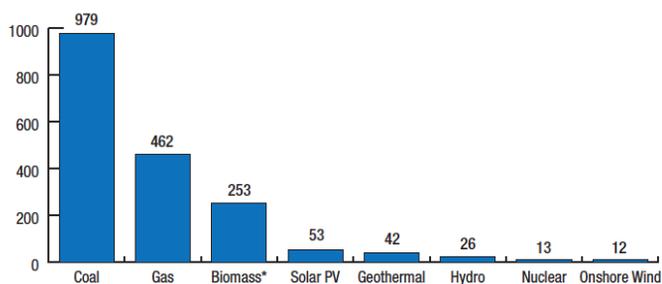

Figure 1 – Lifecycle CO_2 emissions for a selection of fuel and energy types (tonnes of CO_2 per GWh)

All fuel-types are allocated a carbon price based on their carbon intensity weighting: coal, gas, nuclear, even solar. Carbon intensity is the amount of carbon dioxide emitted per amount of useful energy (tonnes of CO_2 per megawatt hour). Prices are dynamic as they respond to changes in the fuel mix used. As new fuel technologies emerge, a new carbon price is provided: the system is future-proof.

A snapshot of the UK Electricity Sector fuel mix in Table 1 shows the energy output, carbon intensity and emissions along with associated CIW carbon prices.

UK Electricity Sector Snapshot Fuel Usage	Carbon Intensity	Energy	Emissions	Carbon Price	Revenue
	e tCO2/MWh	E MW	C=eE tCO2/h	yi=e.f.y.z $/tCO2	Ri=yi.C $/h
UK Biomass	0.983	1,439	1,415	$ 25.87	$ 36,598
UK Coal	0.979	2,606	2,551	$ 25.77	$ 65,739
UK Oil	0.800	0	0	$ 21.06	$ -
UK OCGT (Gas)	0.462	0	0	$ 12.16	$ -
UK CCGT (Gas)	0.359	19,663	7,059	$ 9.45	$ 66,700
UK Solar	0.053	2,380	126	$ 1.39	$ 176
UK Nuclear	0.013	7,756	101	$ 0.34	$ 34
UK Wind	0.012	2,668	32	$ 0.32	$ 10
Totals		36,512	11,284		$ 169,257
PAL Carbon Loss Index (CLIX)	15.00	$/tCO2			
Carbon intensity weighting factor f	3.236	MWh/tCO2			
Revenue weighting factor z	0.542				
Carbon Intensity 1/f	0.309	tCO2/MWh			

Table 1 - Carbon Intensity Weightings and carbon prices for the UK Electricity Sector, where the global carbon price is $15.

The PAL Carbon Intensity Weighting – CIW

The CIW Calculation

The Carbon Intensity Weighting (CIW) provides a spectrum of carbon prices based on impact. The generalized formula used in the CIW calculation is:

$$y_i = e_i . z . y . f \qquad (1)$$

where

$$f = \Sigma \, E_i / \Sigma \, (E_i . e_i) \qquad (2)$$

$$z = \frac{(\,\Sigma\,(\,E_i . e_i\,)\,)^2}{\Sigma \, E_i \, . \, \Sigma \, (\,E_i . e_i{}^2)} \qquad (3)$$

and

y_i	carbon price for a given fuel type i ($/tonne CO_2)
e_i	emission factor for fuel type i (tonne CO_2/GWh)
z	revenue weighting factor
y	global carbon price ($/tonne CO_2)
f	CIW factor
E_i	amount of fuel type i used globally (GWh)

Beyond CIW

CIW prices are used by PAL's Reinsurance Event Attributed Carbon Tax (REACT) system to drive energy policy and incentivise change. The generalized formula used in the REACT revenue calculation is:

$$R_i = E_i . e_i . y_i . N_i \qquad (4)$$

where

R_i	revenue for fuel/energy type i
E_i	amount of fuel type i used globally (GWh)
e_i	emission factor for fuel type i (tonne CO_2/GWh)
y_i	carbon price for a given fuel type i ($/tonne CO_2)
N_i	supplier's proportion of market for fuel/energy type I

Find out more at http://predictability.ltd.uk/

A Carbon Intensity Floor

A problem could arise with Equation (1) if the world completely decarbonised and / or if all the carbon intensities became zero. To avoid this it is recommended that, from the very start, a minimum intensity of, say, 50 gramCO_2/kWh is adopted globally. This would make little difference today but it would future-proof PAL's carbon intensity weighting strategy. Having a carbon intensity floor smoothly converts carbon pricing into energy pricing, in order to help finance the ongoing loss and damage that our global 'carbon legacy' brings.

Navigating the Carbon Labyrinth

Carbon intensity assessment (e)

(a) Is CO_2 captured from the atmosphere? — yes → Carbon rebate[1] based on net CO_2 captured use e = − 1 / f $_{global}$

(b) Is CO_2 captured from a fossil-fuel source? — yes → Carbon rebate based on net CO_2 captured use e = − e_{fuel}

(c) Is there a secondary use for fossil-fuel CO_2? — yes → Carbon price assigned to the first user[2] use e = 0.05 kgCO_2/kWh

Carbon price[3] use e = MAX (e_{fuel}, 0.05)

Notes
[1] f_{global} rises with time as energy decarbonises
[2] greenhouse tomatoes, EOR, algae-based oil, etc.
[3] coal, gas, wind, solar, etc.
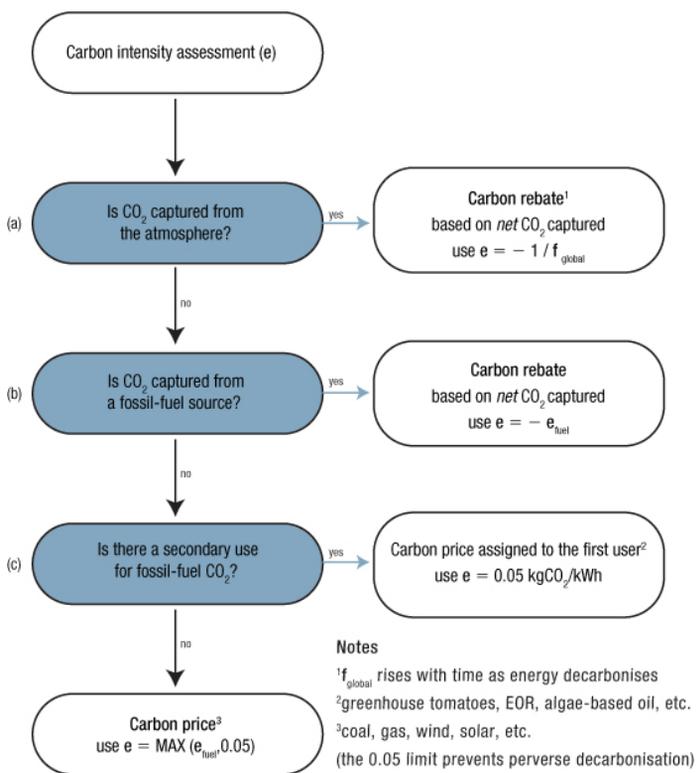(the 0.05 limit prevents perverse decarbonisation)

Figure 2 – The carbon labyrinth

PAL's Carbon Intensity Weighting system provides practical solutions to carbon conundrums, such as how much carbon tax should CO_2-using Enhanced Oil Recovery operators pay for their product. Or what should tomato growers pay if they use waste CO_2. It even helps guide pension funds as they contemplate 'divesting' away from fossil fuels.